

which, from a topographical view, is a trough in the great American Plateau. For 400 miles eastward from its intersection with the western boundary of the State, the surface of this valley ranges from 1,000 to 4,000 feet above sea level, while the mountains that surround it on the north, east, south, and west vary in height from 6,000 to 10,000 feet. Briefly, these are the prominent topographical characteristics of the State of Idaho that bear upon our subject.

It is not generally known that the Snake River Valley, covering one-third of the State, has a climate so mild in the winter season as to be the natural home for stock from the first fall of heavy snow on the mountains until signs of spring appear. In this favored valley thousands of sheep, horses, and cattle seek refuge from the storms and cold waves of winter. Not only does the mildness of the temperature offer inducement to the herder to establish his winter quarters here, but the almost total absence of snow and the presence of growing grass enable the stock to subsist during mild winters upon what nature alone has provided.

Why should the Snake River Valley be mild when to the southward, over the plateau States, the normal condition during the winter season is an area of high pressure prevailing for weeks without great fluctuation? There is no explanation for it unless the air when flowing over the mountains from the high pressure area down into the Snake River Valley is heated by compression.

During the winter season storms pass in succession over the Canadian Northwest bringing Idaho continually within the field of influence, though the center of disturbance almost invariably remains in the north. It is during the prevalence of the storms in the north that Idaho remains in the foothills of the high pressure area prevailing over the plateau States with the barometer (reduced to sea-level) reading 30.40 to 30.80 at Idaho Falls, Salt Lake City, Denver, and Carson City, and moderately high at Baker City, varying, apparently, with the declivity of the depression in the north. The drift of the air from the high pressure area of the Plateau occurs with each appearance of a depression over Alberta, and as the air drifts over the network of mountains to the south and west of the Snake River Valley the principle of dynamic heating comes into operation.

When the high area disappears from the Plateau, permitting the troughs from the low pressure field to sweep southward through the State into Utah, Nevada, and Arizona, then the cold weather occurs in Idaho, since the slightest depression passing southward through the State is productive of a fall in temperature and is sufficient to justify the issuance of frost warnings as late in the season as July.

Since the Weather Bureau established the station at Boise persistent effort has been made to induce those to whom the daily weather map is accessible to comprehend these plain rules. Not until February 2, 1899, when Idaho was visited by a cold wave of unusual severity which resulted in loss of stock, did those who were vitally interested comprehend that their loss would have been materially lessened had they heeded the warnings which gave time for ample protection.

#### STUDIES ON THE ATMOSPHERE AT TRAPPES, FRANCE.

By M. LEON TEISSERENC DE BORT.

Since the autumn of 1897 more than a hundred and fifty kite ascensions have been made at the Trappes Observatory, although the atmospheric conditions are less favorable than those on the American coast.

<sup>1</sup> Translated from the *Journal de Physique*, (3) Vol. IX, March, 1900, pp. 133-137.

These observations demonstrate the importance of inversions of temperature in the vertical, as soon as the cyclonic condition has ceased to exist; a decrease of temperature, very slight in the first 1,200 meters, is an almost certain indication of fine weather the next day.

As with the Americans so with us—our ascensions have increased in height as our materials have improved, and we have learned better how to start the kites.

The vicinity of several lines of railroad, and of quite a crowded network of telegraph wires prevented us in many cases from letting out long lines of kite wire, the slightest accident causing our line to be carried down to the railroad track. Nevertheless, the very first year we attained an elevation of 2,000 meters, then 2,500, and 3,850 meters. Finally, September last, we were able to raise our instruments as high as 4,300 meters.

Whatever be the success obtained by the kite the altitudes reached are necessarily limited. Moreover, they can not ascend at all in calm weather; we must, therefore, have recourse to balloons in order to explore the atmosphere more thoroughly. The ascensions of the "Aérophiles" of Messrs. Hermite and Bésançon showed:

(1) That the temperature was much lower than was supposed from the observations made on mountains, since a temperature of  $-60^{\circ}$  was found at an altitude below 14,000 meters.

(2) That the gas inside of the balloon cooled very rapidly, so as to approach the theoretical temperature obtained by the expansion of the gas for the same differences of pressure. This fact, which has been neglected up to the present time, because it is generally concealed by the great rise of temperature produced when the balloon is exposed to the sun, is of considerable practical importance, and must be taken into account in calculating the height that can be reached by a balloon ascending in the night.

(3) These ascensions have led M. Hermite to construct a form of shelter called "parasoliel," for sheltering the instruments from solar radiation. This "parasoleil" consists of a paper tube blackened on the inside, and covered on the outside with a sheet of metal in such a way as to become heated to the least possible degree under the direct action of the sun.

Since the meteorological conference at Paris in 1896, an international agreement has been entered into, and at certain fixed times, sounding balloons have been sent up from Paris, Berlin, Strasburg, Vienna, Munich, and St. Petersburg. These ascensions, six in number, are not as yet sufficiently numerous to lead to the discovery of very precise laws, but have enabled us to study the methods and to explain many details.

In view of the diversity in the atmospheric conditions and of the rapidity with which the phenomena change from day to day, I have thought it necessary to make very frequent aerial soundings—when necessary, several times a week—and for this purpose we have first turned our attention to rendering the usage of sounding balloons more simple and less expensive.

We have attained this result by employing pure hydrogen, which allows of greatly diminishing the diameter of the balloons and of diminishing the weight of the instruments sent up, without, however, impairing their accuracy.

In order to send up these balloons even in violent winds or stormy weather, which has scarcely ever been attempted, but is of the greatest interest, I sought a device which would enable us to start the balloon, when once it is inflated, without exposing it to injury from the very first gusts, since we desire always to use extra light netting. For this purpose I adopted the following arrangement: I constructed, upon a revolving table, a very light tent, open on one side. The balloon once

inflated in this tent, care is taken to keep the opening turned away from the wind. The instruments are attached to the balloon, as is also a "ballast heaver," filled with sand or some liquid and provided with an aperture arranged in such a manner that it can empty itself in the proper interval, generally in about forty minutes. The balloon is then brought to the door of the tent; the ballast heaver is supported so as to facilitate the rising of the balloon a little, and the whole is then launched into the air with the least possible shake. Thanks to this device, we have been able to send up sounding balloons during storms in which the wind reached a velocity of 14 meters per second.

To avoid the disturbing influence of the rays of the sun and, above all, the radiation of the upper clouds when they are in great masses and form that sea of dazzling clouds so well known to alpine travelers and aeronauts, we have made the greater number of our night ascensions at first by moonlight—with a great deal of trouble, I must confess—and afterwards, when I succeeded in improving our apparatus, by electric light. Since the month of March, 1899, we have sent up more than a hundred and twenty balloons which have brought back curves of pressure and temperature. The height of 13,000 meters has been attained twenty-four times; 14,000 meters, eight times; 15,000 meters, three times.

We can with our present outfit reach a height of 13,000 meters nearly every time.

Confining the discussion of the observations collected to the atmosphere up to a height of 10,000 meters, the region explored by the greater number of the balloons, we see:

1. That the differences of temperature from one day to another may be greater at 7,000 or 8,000 meters than those observed the same day near the ground. This fact is of considerable importance and is besides contrary to the ideas we had previously formed on the subject.

2. We see that the temperature diminishes much faster near the centers of depression than elsewhere. This diminution reaches in certain cases about  $0.90^{\circ}$  C. per 100 meters.

Finally, it is remarked that in a great many areas of high pressure—I do not say in all—the decrease of temperature takes place in the following manner: from the ground to 1,500 or 2,000 meters the temperature varies little and sometimes even increases, after which it begins to diminish in a normal manner, and finishes by reaching at 9,000 or 10,000 meters a decrease of  $1^{\circ}$  per 100 meters. If we compare these values with those observed in the low areas we see that the variation in the vertical shows ordinarily the following characteristics:

The lower strata are often warmer in the areas of low pressure than in the areas of high pressure; but above several hundred meters of altitude the rapid diminution of temperature produces lower temperatures in the low areas.

Thus, the center of a depression at about 3,000 or 4,000 meters altitude is ordinarily colder than the corresponding part of the barometric maximum. This fact had already been demonstrated by Hann in his mountain observations; but the sounding balloons, while confirming this first result, show that higher up the temperatures have again a tendency to equalize themselves, and this is of great importance relative to the form of the upper isobars.

I would like to be able to say a few words about the temperature of the highest atmosphere, that which extends above the ordinary region of the cirrus clouds; but notwithstanding that we have observations at these altitudes, we shall have to wait to discuss them until we are certain that the thermometer—when the air is so greatly rarefied—is able, by simple contact, to come into thermal equilibrium with its surroundings. If it cannot, then we shall have to make use of special methods for determining the temperature at high altitudes.

## MONTHLY STATEMENT OF AVERAGE WEATHER CONDITIONS FOR JANUARY.

By Prof. E. B. GARRIOTT.

The following statements are based on average weather conditions for January, as determined by long series of observations. As the weather of any given January does not conform strictly to the average conditions the statements can not be considered as forecasts:

January is a month of severe storms in the middle latitudes of the North Atlantic Ocean. Along the transatlantic steamship tracks these storms set in with southeast gales which shift to west and northwest with freezing temperature. Westward bound vessels experience sudden shifts of wind from the southeast and storms of comparatively short duration, and have prevailing strong head (westerly) winds. Storms encountered by eastward bound vessels are fewer in number and of longer duration; the vessels and the storms travel in the same direction. Storms seldom appear in the tropical regions of the Atlantic and Pacific oceans in January. On the north coast of western Cuba, however, and in the Gulf of Mexico, high and cold north winds are not uncommon during the winter months.

In the Lake region and the Atlantic coast districts of the United States the severest January storms come from the middle-West and Southwest, with northeast shifting to northwest gales; snow occurs on the north and rain or light snow on the south of the paths of the storms. In the Pacific coast States the rainy season is at its height, and strong gales occur from the central California coast to Alaska. In the Plateau and Rocky Mountain districts and on the great Plains the prevailing weather is fine and cold. This entire region is, however, subject to occasional cold waves of great severity, which, with snow and high winds, sweep southward to New Mexico and Texas and sometimes to the Rio Grande and northern Mexico, causing great losses of stock on the great ranges.

Frost is likely to occur in any part of the United States in January, and about once in five years severe freezes occur in the Gulf coast districts and in central and northern Florida.

## CLIMATOLOGY OF COSTA RICA.

Communicated by H. PITTIER, Director, Physical Geographic Institute.

In communicating this abstract of the meteorological observations made in Costa Rica during January, 1901, and under date of February 20, Mr. Pittier says:

As far as the southwestern slope of this country is concerned, I do not think that agriculture is very much affected by any of our usual meteorological phenomena. As we have only one complete station, it would not be possible to construct charts of isobars, isotherms, and isohyets of Costa Rica. But I shall endeavor to establish a storm service so that we will be informed by telegraph of any storm occurring on the northeastern slope. Next week I go to Limon to establish a station there, the outfit of which will include a mercurial barometer, a registering aneroid, dry and wet bulb thermometers, Richard's dry and wet bulb registering thermometers, maximum and minimum thermometers, and the old rain gage. I have brought, also, a special outfit for the United Fruit Company, which I am going to put up at their farms at Zent. It includes one psychrometer, one maximum and one minimum thermometer, one pair maximum actinometers, one Jordan's sunshine recorder, and three earth thermometers. Mr. John Meiggs Keith, the General Manager of the Costa Rica division of the United Fruit Company, promises me to complete the outfit of instruments if we can obtain a good and permanent observer. As no white man can withstand indefinitely the mortiferous climate of Zent, I will try to get a young Jamaican negro, and bring him here for a few weeks, to be well instructed in the management of instruments, and then send him down.

METEOROLOGICAL